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GENERAL MOTORS CORPORATION

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**LUNAR SOIL PROPERTIES MEASURING DEVICE
ASSOCIATED TEST EQUIPMENT**

OPERATION AND MAINTENANCE

OTS PRICE

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DEFENSE RESEARCH LABORATORIES
SANTA BARBARA, CALIFORNIA



LAND OPERATIONS



OM 62-201

NOVEMBER 1962

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This work was performed for the Jet Propulsion Laboratory,
California Institute of Technology, sponsored by the
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CLASS II

LSPMD TEST CONSOLE

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LSPMD TEST CONSOLE

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SECTION I INTRODUCTION

1-1. SCOPE OF MANUAL

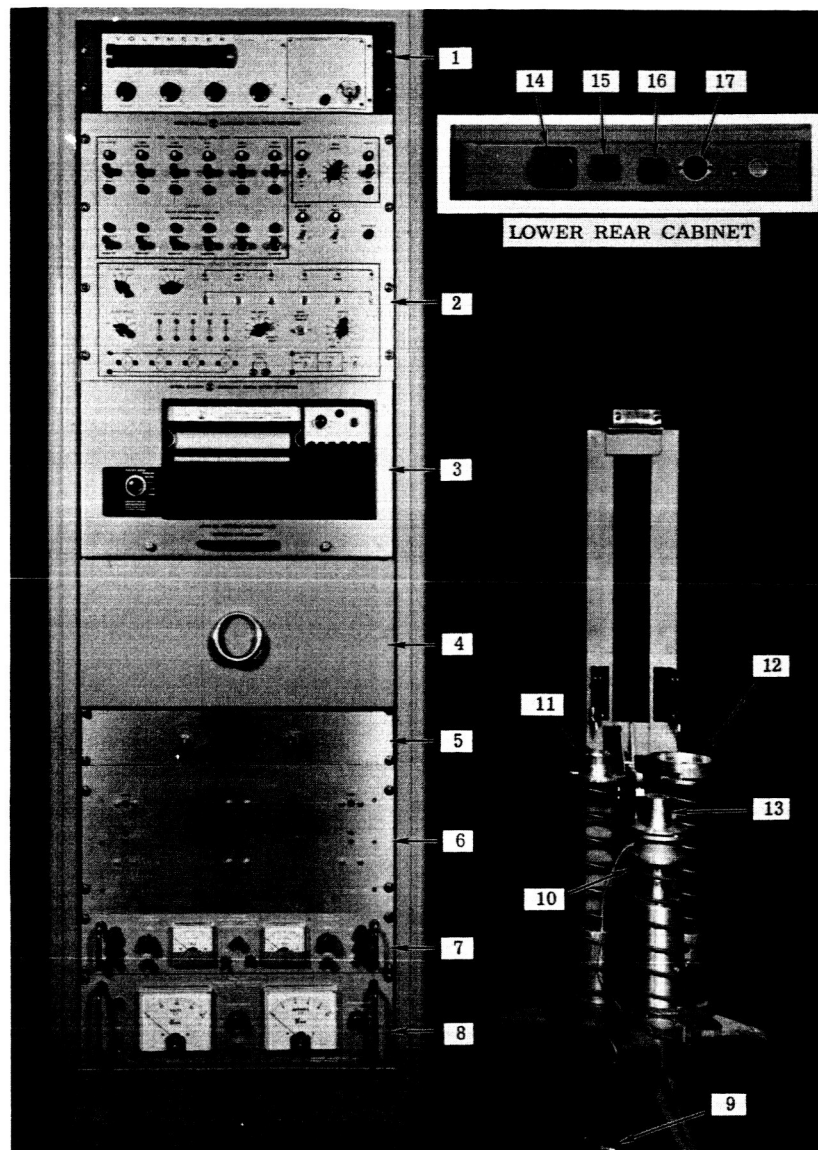
This manual describes the functions of the Lunar Soil Properties Measuring Device (LSPMD) Test Console and Test Fixture. Instructions are included for preliminary operation and calibration of the Test Console. Operating instructions describe the use of the test console in terms of LSPMD functions; however, detailed test procedures are governed by applicable LSPMD test specifications and are not included here. Circuit analysis of the test console is included to assist in troubleshooting.

1-2. PURPOSE OF EQUIPMENT

The LSPMD Test Console and Test Fixture are used to perform functional checks of the Lunar Soil Properties Measuring Device (LSPMD). The console provides operating voltages and controls, and monitors output signals from LSPMD strain gages and potentiometers. The test fixture provides a mount and mechanical loads for the LSPMD. Strain gages in the test fixture respond to LSPMD operations and are monitored by the test console.

1-3. DESCRIPTION OF TEST CONSOLE

(See Fig. 1-1.) The Test Console is composed of a control panel, oscillograph recorder, digital voltmeter, and regulated power supplies. The oscillograph simultaneously records signals from the LSPMD and test fixture to provide a comparison of LSPMD operation against standards from the fixture. The digital voltmeter is used to display individual signals from each of the strain gages and potentiometers of the LSPMD and test fixture. The voltmeter is also used to check the power supply voltages and provide continuity checks of LSPMD components. A connector (J1) is provided to supply all monitored signals to an external magnetic recorder.



- | | | |
|---|---------------------------------|----------------------------------|
| 1 Digital Voltmeter | 7 17 and 22-volt Power Supplies | 13 Shear Load Assy. |
| 2 Control Panel | 8 24-volt Power Supply | 14 Receptacle J2 (LSPMD) |
| 3 Oscillograph Recorder | 9 Plug P10 (LSPMD) | 15 Receptacle J3 (Fixture) |
| 4 Cable Storage Drawer | 10 Receptacle J1 | 16 Receptacle J1 (Tape Recorder) |
| 5 Power Control Panel | 11 2-inch Load Assy. | 17 115-volt 60 cps Receptacle |
| 6 4. 85, 6, 5, 10, and 20-volt Power Supplies | 12 4-inch Load Assy. | |

Figure 1-1. LSPMD Test Console and Test Fixture

1-4. DESCRIPTION OF TEST FIXTURE

(See Fig. 1-1.) The test fixture is a simulated-soil load for the LSPMD and has three spring assemblies which are compressed by the LSPMD pads, as they descend. Each spring exerts force on a load cell, which provides a signal representing the thrust load on the LSPMD pad. The spring load for the shear unit of the LSPMD is driven down by a motor in the fixture as the shear descends, simulating the effect of soil receding from the rotating shear. In addition to measuring thrust, the shear unit assembly measures torque developed against a strain gage by the rotating shear.

1-5. SCHEMATIC INFORMATION REQUIRED

This manual is intended for use in conjunction with the following General Motors DRL blueprints: (Supplied with equipment)

Test Console Control Panel Schematic SK01876

Test Console Interconnecting Diagram SK01072

Test Fixture Schematic SK00656

1-6. MANUFACTURER'S MANUALS REQUIRED

Manufacturer's operation and maintenance manuals are required for the following assemblies of the test console:

Digital Voltmeter

Cimron Model 6200A

(Cimron Corp.

1152 Morena Boulevard

San Diego 10, California)

Oscillograph Recorder

CEC Recording Oscillograph Type 5-124

(Consolidated Electrodynamics Corp.

360 Sierra Madra Villa

Pasadena, California)

4. 85-volt, 5. 0-volt, and
20. 0-volt Power Supplies

Harrison Laboratories Model 801C
(Harrison Laboratories Inc.
45 Industrial Road
Berkeley Heights, New Jersey)

6. 0-volt and 10-volt
Power Supplies

Harrison Laboratories Model 850

17-volt and 22-volt Twin
Power Supply

Harrison Laboratories Model 802 B

24-volt Power Supply

Harrison Laboratories Model 510 A

1-7. CABLES

The two cables supplied connect the console to the LSPMD and fixture as follows:

Connectors on Cable

P2 and P10

P3 and P1

Mate With

J2 (Test Console) and J10 (LSPMD)

J3 (Test Console) and J1 (Fixture)

SECTION II OPERATING INSTRUCTIONS

CAUTION

Do not connect console to LSPMD until directed by applicable procedures in this section.

This section describes functions and directs preliminary operations for using the test console and fixture with the LSPMD. Detailed procedures for testing the LSPMD depend on the applicable developmental or pre-flight LSPMD test specification and are not included in this manual.

2-1. FUNCTIONS OF CONTROLS

2-2. Control Panel. (See Fig. 2-1.) Table 2-1 lists functions of all operating and adjustment controls, indicators, and test jacks in the control panel.

2-3. Power Control Panel. (See Fig. 2-4.)

AC POWER	Controls 115 v, 60 cps input to all power supplies, digital voltmeter, and recorder.
DC POWER	Controls application of +24 volts to control panel.

2-4. Digital Voltmeter. (See Fig. 2-2.) The operating controls on the digital voltmeter function as follows: (For use of adjustment controls within the digital voltmeter, see manual for Cimron Model 6200A.)

POWER	In OFF position, ac input power is disconnected. In STANDBY, ac power is applied but meter does not search. In ON, meter is ready for use.
FUNCTION	Selects ac or dc operation. (only DC is used)

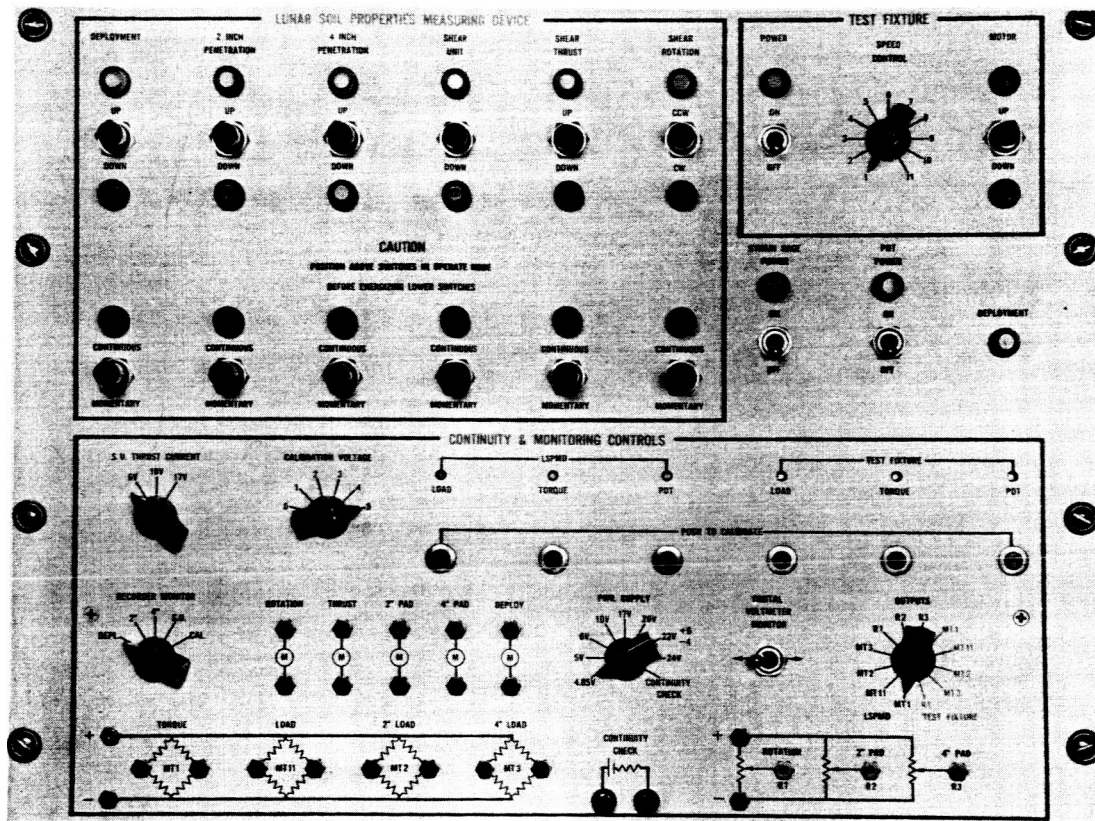


Figure 2-1. Control Panel

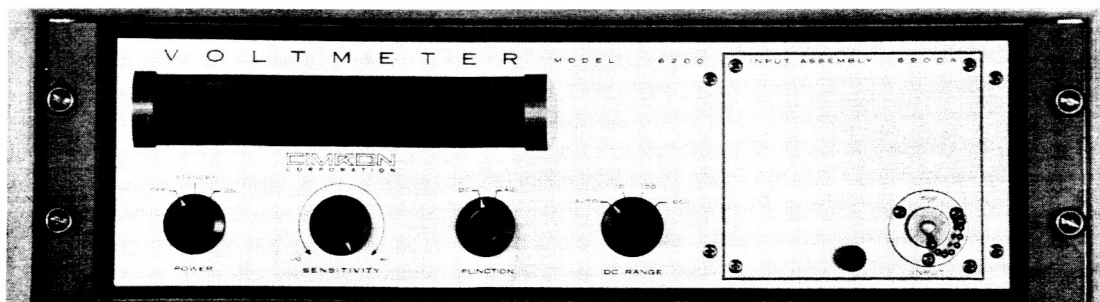


Figure 2-2. Digital Voltmeter Panel

DC RANGE Selects ranges of 10, 100, 1000 volts, or automatic ranging of 0 to 1000.

SENSITIVITY Determines minimum voltage required to unbalance the meter. (Maximum sensitivity is at HI position.)

2-5. Oscillograph Recorder. (See Fig. 2-3.) The operating controls on the oscillograph recorder function as follows: (For use of adjustment controls within recorder, see manual for Consolidated Electrodynamics Type 5-124.)

POWER Controls AC input to recorder.

LAMP Starts galvanometer illumination arc-lamp. (Button is pressed momentarily and repeated if necessary to start lamp.)

MOTOR (Red Button).25, Starts and stops chart transport motor.
1, 4, 16, and 64 (Buttons) Select transport speed.

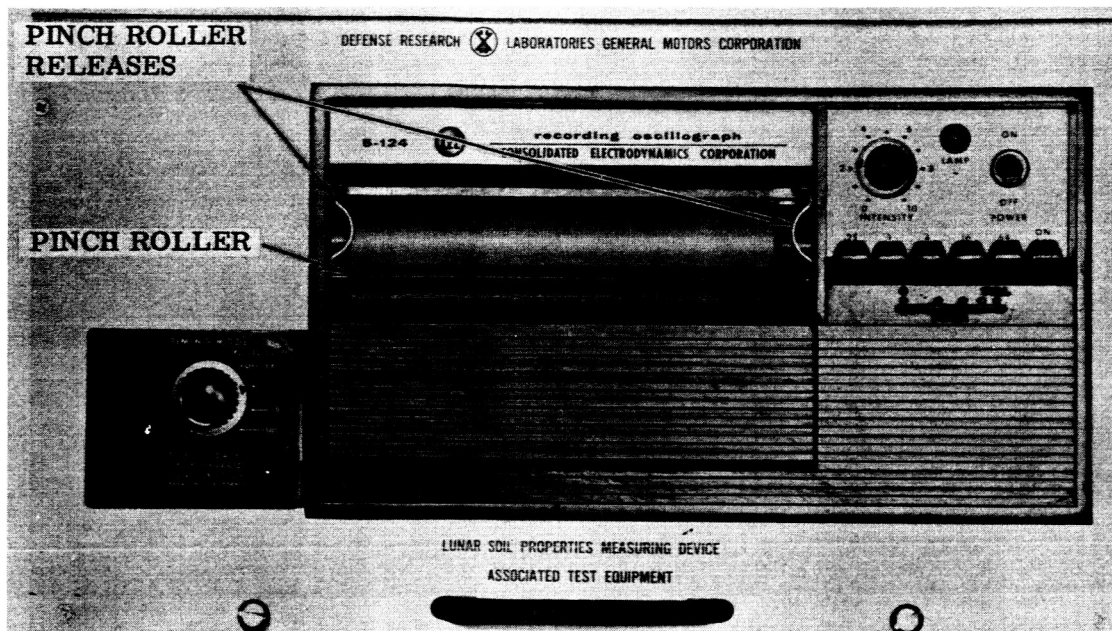
INTENSITY Controls intensity of trace beam. (Higher intensity setting used for legible trace at faster transport.)

2-6. Power Supplies. (See Fig. 2-4.) Functions of power supply adjustment controls are shown in figure 2-4.

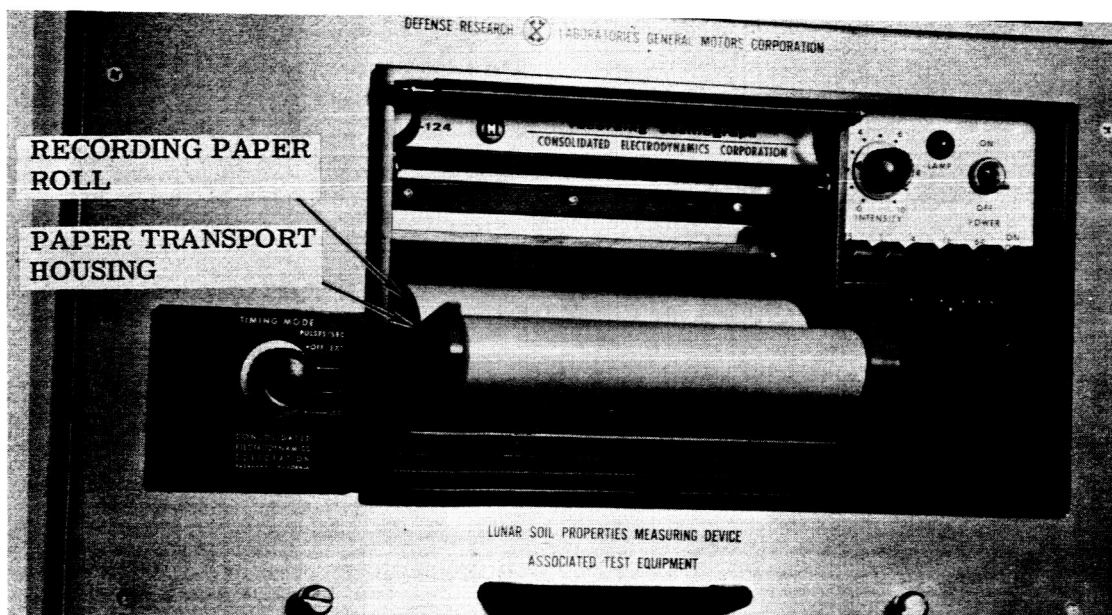
2-7. PREPARING TEST CONSOLE FOR USE

2-8. Loading the Recorder Chart. (See Fig. 2-3.)

- a. Release pinch-roller.
- b. Lower paper transport housing.
- c. Drop roll of recording paper in place. Paper should feed from bottom of the roll.
- d. Close paper transport housing.
- e. Replace pinch-roller, making sure that pinch-roller releases are firmly seated.



CLOSED



OPEN

Figure 2-3. Recorder Panel

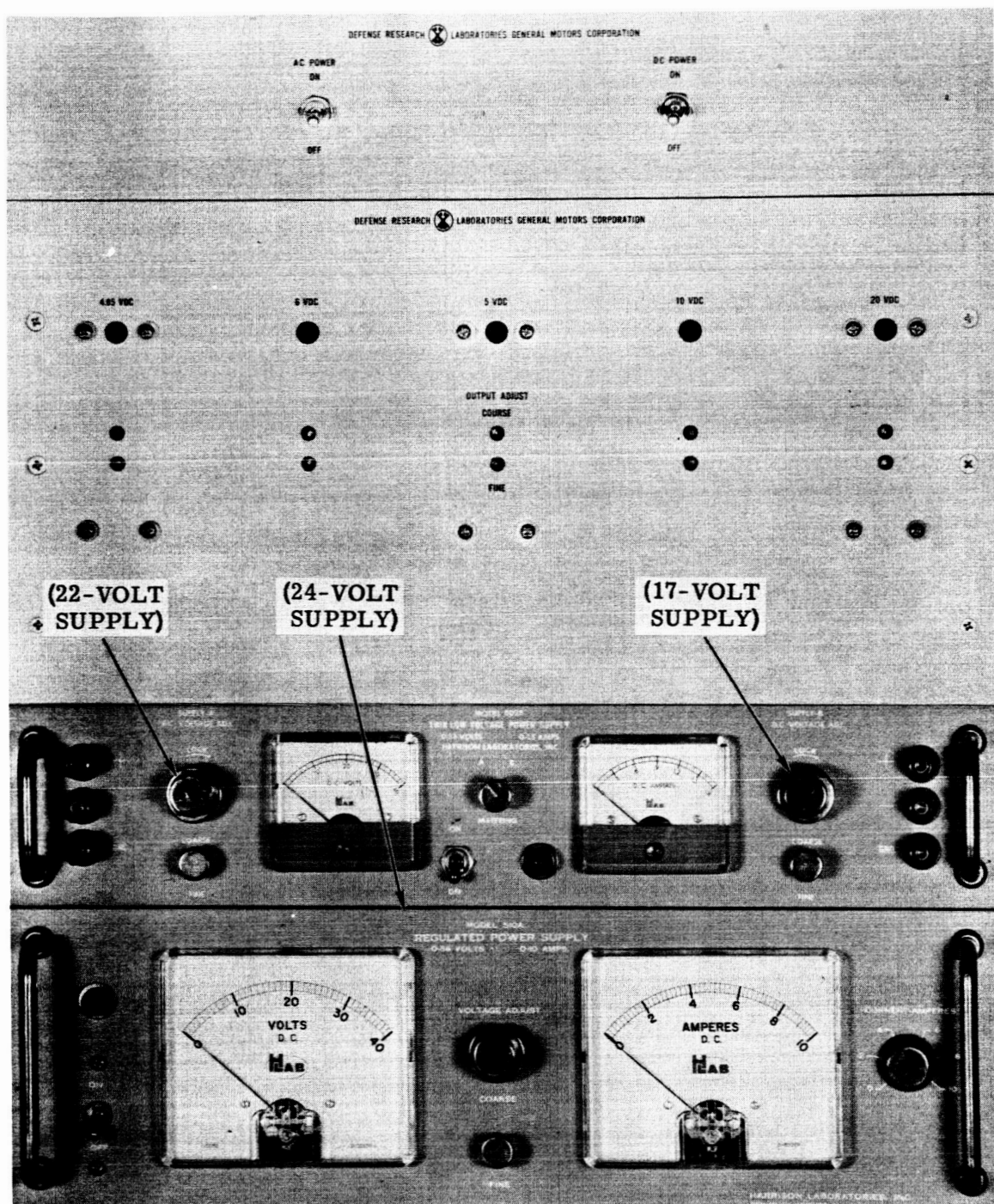


Figure 2-4. Power Control Panel and Power Supplies

Table 2-1 Control Panel Functions (See Fig. 2-1.)

Panel Designation	Schematic Desig.	Function
LUNAR SOIL PROPERTIES MEASURING DEVICE CONTROLS		
DEPLOYMENT	S 1	Determines what the direction of deployment will be for all three LSPMD units when the continuous-momentary switch located directly below is operated.
UP (light)	DS 1	Indicates that DEPLOYMENT switch is set at UP .
DOWN (light)	DS 9	Indicates that DEPLOYMENT switch is set at DOWN .
CONTINUOUS-MOMENTARY (Switch)	S 10	When set at CONTINUOUS , drives all three LSPMD units down if DEPLOYMENT switch is set at DOWN . (CONTINUOUS position cannot drive pads UP .) When held at MOMENTARY , drives all pads UP or DOWN , as determined by position of DEPLOYMENT switch.
CONTINUOUS (light)	DS 16	Indicates that CONTINUOUS-MOMENTARY switch is set at CONTINUOUS .

Panel Designation	Schematic Desig.	Function
2 INCH PENETRATION UP DOWN (Switch)	S 2	Determines what direction the 2- inch pad will be driven when the CONTINUOUS-MOMENTARY switch located directly below is operated.
UP (light)	DS 2	Indicates that 2 INCH PENETRA- TION switch is set at UP.
DOWN	DS 10	Indicates that 2 INCH PENETRA- TION switch is set at DOWN.
CONTINUOUS-MOMENTARY (Switch)	S 11	When set at CONTINUOUS, drives 2-inch pad down if 2 INCH PENETRATION switch is set at DOWN. (CONTINUOUS position cannot drive pad up.) When held at MOMENTARY, drives 2-inch pad up or down, as deter- mined by position of 2 INCH PENETRATION switch.
CONTINUOUS (light)	DS 17	Indicates that CONTINUOUS- MOMENTARY switch is set at CONTINUOUS.

Panel Designation	Schematic Desig.	Function
4 INCH PENETRATION UP DOWN (Switch)	S 3	Determines what direction the 4-inch pad will be driven when the CONTINUOUS-MOMENTARY switch located directly below is operated.
UP (light)	DS 3	Indicates that 4 INCH PENETRATION switch is set at UP.
DOWN (light)	DS 11	Indicates that 4 INCH PENETRATION switch is set at UP.
CONTINUOUS-MOMENTARY (Switch)	S 12	When set at CONTINUOUS, drives 4-inch pad down if 4 INCH PENETRATION switch is set at DOWN. (CONTINUOUS position cannot drive pad up). When held at MOMENTARY, drives pad up or down, as determined by position of 4 INCH PENETRATION switch.
CONTINUOUS (light)	DS 18	Indicates that CONTINUOUS-MOMENTARY switch is set at CONTINUOUS.
SHEAR UNIT DOWN (Switch)	S 4	Determines that shear unit will be driven downward and simultaneously rotated when CONTINUOUS-MOMENTARY switch located directly below is operated.

Panel Designation	Schematic Desig.	Function
DOWN (light)	DS 12	Indicates that SHEAR UNIT switch is set at DOWN.
CONTINUOUS-MOMENTARY (Switch)	S 13	When SHEAR UNIT switch is at DOWN, drives downward and rotates shear unit.
CONTINUOUS (light)	DS 19	Indicates that CONTINUOUS-MOMENTARY switch is set at CONTINUOUS.
SHEAR THRUST UP DOWN (Switch)	S 5	Determines what direction shear unit thrust motor will be driven when CONTINUOUS-MOMENTARY switch located directly below is operated.
UP (light)	DS 5	Indicates that SHEAR THRUST switch is set at UP.
DOWN (light)	DS 13	Indicates that SHEAR THRUST switch is set at DOWN.
CONTINUOUS-MOMENTARY (Switch)	S 14	Drives shear unit thrust motor up or down, as determined by position of SHEAR THRUST switch. (Does not rotate shear.)
CONTINUOUS (light)	DS 20	Indicates that CONTINUOUS-MOMENTARY switch is set at CONTINUOUS.

Panel Designation	Schematic Desig.	Function
SHEAR ROTATION CCW CW (Switch)	S 6	Determines direction of shear rotation when CONTINUOUS-MOMENTARY switch located directly below is operated.
CCW (light)	DS 6	Indicates that SHEAR ROTATION switch is set at CCW.
CW (light)	DS 14	Indicates that SHEAR ROTATION switch is set at CW.
CONTINUOUS-MOMENTARY (Switch)	S 15	Rotates shear counterclockwise or clockwise, as determined by position of SHEAR ROTATION switch. (Does not drive shear unit up or down.)
CONTINUOUS (light)	DS 21	Indicates that CONTINUOUS-MOMENTARY switch is set at CONTINUOUS.
STRAIN GAGE POWER ON OFF (Switch)	S 16	Applies + 20-volt DC power to all load cells and torque cell, in LSPMD.
ON (light)	DS 22	Indicates that STRAIN GAGE POWER switch is set at ON.
POT POWER ON OFF (Switch)	S 17	Applies +4.85 volts DC power to both thrust potentiometers and rotation potentiometer, in LSPMD.

Panel Designation	Schematic Desig.	Function
ON (light)	DS 23	Indicates that POT POWER switch is set at ON.
DEPLOYMENT (light)	DS 24	Indicates that LSPMD has been deployed to position at which deployment sensor has been engaged and deployment motor stopped.

TEST FIXTURE CONTROLS (on control panel)

POWER ON OFF (Switch)	S 7	Applies +4.85 volts DC power to load cells and rotation potentiometer, in test fixture.
ON (light)	DS 7	Indicates that PWR switch is at ON.
MOTOR UP DOWN (Switch)	S 9	Drives test fixture shear unit load up or down.
UP (light)	DS 8	Indicates that MOTOR switch is at UP.
DOWN (light)	DS 15	Indicates that MOTOR switch is at DOWN.
SPEED CONTROL (Switch)	S 8	Determines voltage applied to test fixture motor when MOTOR switch is operated.

Panel Designation	Schematic Desig.	Function
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CONTINUITY AND MONITORING CONTROLS

RECORDER MONITOR S 26 Selects simultaneous inputs to oscillograph recorder as follows: (Recorder trace number identification is shown in fig. 2-7.)

<u>Position</u>	<u>Recorder Trace No.</u>	<u>Inputs</u>
DEPL.	4	deployment motor voltage
	6	deployment motor current
2"	4	2-inch unit motor voltage
	6	2-inch unit motor current
	9	2-inch LSPMD load cell output
	11	2-inch potentiometer output
	13	2-inch test fixture load cell output
4"	4	4-inch unit motor voltage
	6	4-inch unit motor current
	9	4-inch LSPMD load cell output
	11	4-inch potentiometer output
	13	4-inch test fixture load cell output

Panel Designation	Schematic Desig.	Function	
RECORDER MONITOR (Continued)	<u>Position</u>	<u>Recorder Trace No.</u>	<u>Inputs</u>
	S. U.	4	shear unit rotation motor voltage
		5	shear unit thrust motor voltage
		7	shear unit thrust motor current (voltage at which current is meas- ured is determined by position of S. U. THRUST CURRENT switch)
		6	shear unit rotation motor current
		9	LSPMD shear load cell output
		10	LSPMD shear torque cell output
		11	LSPMD rotation potentio- meter output
		13	Test fixture shear load cell output
		14	Test fixture torque cell output
		15	Test fixture rotation potentiometer output

Panel Designation	Schematic Desig.	Function	
RECORDER MONITOR (Continued)	<u>Position</u>	<u>Recorder Trace No.</u>	<u>Inputs</u>
		Note	
		LSPMD potentiometer and load cell input voltages (trace nos. 2 and 3) are monitored by recorder continuously, independent of RECORDER MONITOR switch.	
	CAL	9 thru 11 13 thru 15	Calibration voltage applied individually to each input as selected by PUSH TO CALIBRATE switches. Voltage value determined by CALIBRATION VOLTAGE switch.
S. U. THRUST CURRENT	S 18	Selects shear thrust circuit to be monitored when RECORDER MONITOR is at S. U.	
CALIBRATION VOLTAGE	S 19	Selects value of calibrating voltage to be applied to recorder input circuits when RECORDER MONITOR is at CAL. and any PUSH TO CALIBRATE button switch is pressed.	

Panel Designation	Schematic Desig.	Function
LSPMD and TEST FIXTURE (Screw-driver adjusted pots.)	R 401 thru R 406	Determines deflection of recorder trace for given input. Adjusted when RECORDER MONITOR is at CAL and adjacent PUSH TO CALIBRATE button is pressed. Calibration voltage value is determined by position of CALIBRATION VOLTAGE switch. Jacks to which calibration voltage is applied for each pushbutton are as follows:
LSPMD: (Pushbutton and pots.)		
LOAD (pot.)	R 406	J 10
(pushbutton)	S 20	
TORQUE (pot.)	R 405	J 11
(pushbutton)	S 21	
POT (pot.)	R 404	J 12
(pushbutton)	S 22	
TEST FIXTURE: (pushbuttons and pots.)		
LOAD (pot.)	R 403	J 13
(pushbutton)	S 23	
TORQUE (pot.)	R 402	J 14
(pushbutton)	S 24	
POT (pot.)	R 401	J 15
(pushbutton)	S 25	

Panel Designation	Schematic Desig.	Function
DIGITAL VOLTMETER MONITOR (Switch)	S 28	Switches digital voltmeter input to either PWR. SUPPLIES switch or OUTPUTS switch for voltage selection.
PWR. SUPPLIES (Switch)	S 27	When DIGITAL VOLTMETER MONITOR is at PWR. SUPPLIES (left), selects each of the test console power supply outputs or the continuity-check circuit. With PWR. SUPPLIES switch at CONTINUITY CHECK all voltages are removed from the LSPMD and digital voltmeter becomes continuity indicator.
CONTINUITY CHECK (jacks)	TP 26 TP 27	Provides input for continuity check circuit when PWR. SUPPLIES switch is at CONTINUITY CHECKS position. Test leads may be connected from CONTINUITY CHECK jacks to other front-panel jacks for continuity measurements across the following LSPMD components:
JACKS:		
Rotation M	TP 1 TP 2	Shear unit rotation motor
THRUST M	TP 3 TP 4	Shear unit thrust motor

Panel Designation	Schematic Desig.	Function
2" PAD M	TP 5 TP 6	2-inch unit thrust motor
4" PAD M	TP 7 TP 8	4-inch unit thrust motor
DEPLOY M	TP 9 TP 10	Deployment motor
+ and - (across torque and load cells)	TP 11 TP 12	Input to all load cells and torque cell
MT 1	TP 13 TP 14	Shear unit torque cell output
MT 11	TP 15 TP 16	Shear unit load cell output
MT 2	TP 17 TP 18	2-inch unit load cell output
MT 3	TP 19 TP 20	4-inch unit load cell output
+ and - (across potentio- meters)	TP 21 TP 22	Input to all pots.
ROTATION R1	TP 23	Shear unit rotation pot. output
2" PAD R2	TP 24	2-inch unit thrust pot. output
4" PAD R 3	TP 25	4-inch unit thrust pot. output

Panel Designation	Schematic Desig.	Function
OUTPUTS (Switch)	S 29	When DIGITAL VOLTMETER MONITOR is at OUTPUTS position (right), selects any load cell or pot. of LSPMD or test fixture for indication on digital voltmeter.

INTERNALLY LOCATED CONTROLS (See Fig. 2-5.)

S 30	By-passes 2-inch motor load-limit switch.
S 31	By-passes 4-inch motor load-limit switch.
R 301	Calibrates pot. power recorder monitoring circuit.
R 302	Calibrates shear unit thrust motor voltage monitoring circuit.
R 303	Calibrates strain gage power recorder monitoring circuit.
R 307	Calibrates 2-inch, 4-inch, deployment, and shear rotation motor voltage monitoring circuit.
R 141	Adjusts calibration voltage for test fixture load and torque cell recording circuits.

2-9. Power-On Procedure

Note

Before connecting console to power source, place AC POWER and DC POWER switches, located on power control panel, at OFF.

Power Cable:

Connect power cable to 115-volt, 60 CPS power source.

Digital Voltmeter Panel:

- a. POWER at ON
- b. Sensitivity at HI
- c. FUNCTION at DC
- d. DC RANGE at AUTO

Power Control Panel:

- a. AC POWER at ON
- b. DC POWER at ON

Recorder Panel:

- a. POWER at ON (If chart runs, stop motor by pressing red ON-OFF button)
- b. Press LAMP button momentarily. Repeat until galvanometer lamp is lighted.

Note

Allow 20-minute warmup period before proceeding to para. 2-10.

2-10. Power Supply Check and Adjustment

- a. Place DIGITAL VOLTMETER MONITOR switch at PWR. SUPPLIES (left)

- b. Set PWR. SUPPLIES switch at each of the eight voltage positions and observe digital voltmeter indications. Adjust power supplies, as necessary, to obtain indications corresponding to each position (adjust for 22.0 volts on 22V position). See Fig. 2-4 for adjustment locations.)

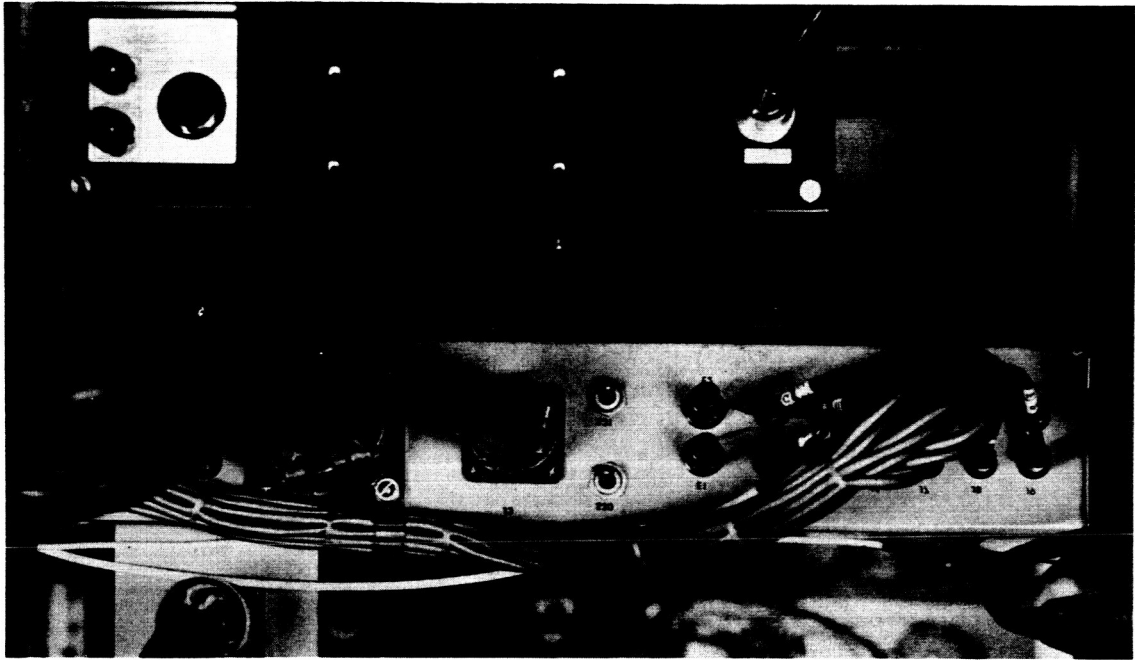
2-11. Calibration of Monitoring Circuits (See Fig. 2-5 for location of adjustment controls.)

S. U. Voltage Pot. R 302: (Perform twice daily)

- a. Place RECORDER MONITOR at S. U.
- b. Connect a jumper between X and k of P 10. (This connects the 17-volt line to the thrust-motor voltage monitoring line.
- c. Connect a jumper between J and n of P 10. (This connects the terminals normally connected by the 17-volt S. U. switch.)
- d. Place SHEAR UNIT switch S4, at DOWN.
- e. Place SHEAR UNIT CONTINUOUS MOMENTARY switch S 13, at CONTINUOUS.
- f. At oscillograph recorder, press red ON-OFF button to start recorder chart.
- g. Adjust R 302 to obtain a 5-inch deflection of trace No. 5 on the recorder chart. (The trace number is indicated by the position of the gap in the trace. See Fig. 2-7.)
- h. Stop recorder and disconnect the jumper from between J and n of P 10.

Note

In the next two steps the trace is measured for the 6-volt and 10-volt inputs. This provides reference for use in LSPMD tests and a check of recorder linearity. Perform the steps once a week.



REAR

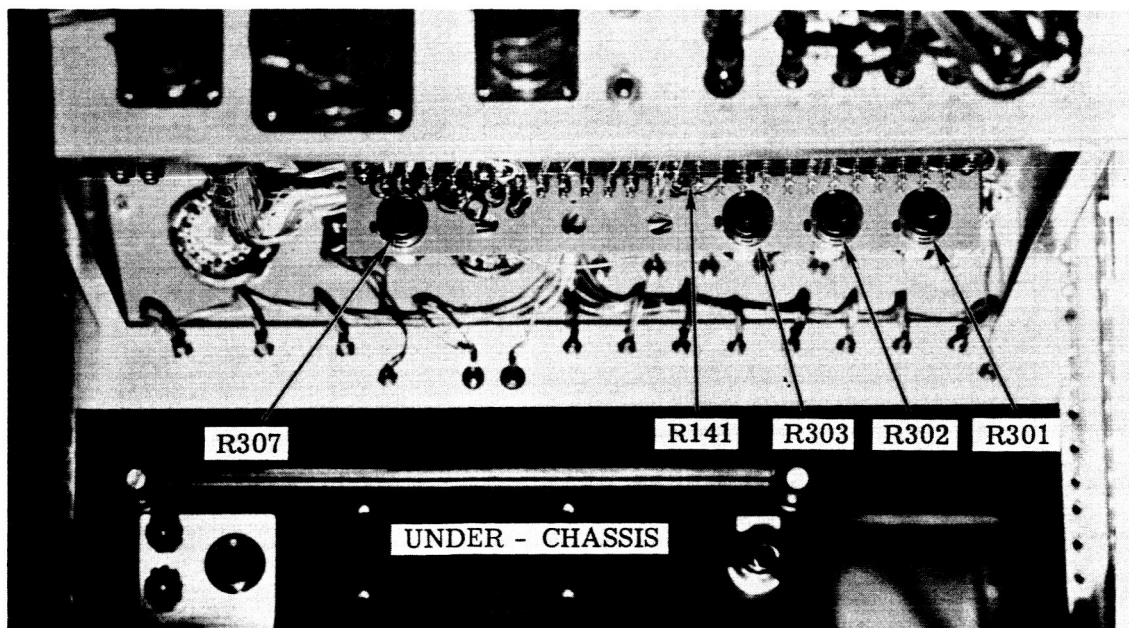


Figure 2-5. Control Panel, Rear

- i. Connect a jumper between J and d of P 10 (6-volt circuit). Measure and note deflection for trace No. 5.
- j. Disconnect jumper from J and d and connect jumper between J and L (10-volt circuit). Measure and note deflection for trace No. 5.
- k. Place SHEAR UNIT UP-DOWN and CONTINUOUS-MOMENTARY switches at center (off) positions.
- l. Disconnect jumpers from between J and n and between X and k of P 10.

Deployment, 2-inch, 4-inch 2nd Rotation Pot. R307: (Perform twice daily)

- a. Place RECORDER MONITOR at DEPL.
- b. Place DEPLOYMENT switch S1 at DOWN and DEPLOYMENT CONTINUOUS-MOMENTARY switch S10 at CONTINUOUS.
- c. Adjust R 307 to obtain a 4-inch deflection for trace No. 4. (This is reference for 22-volt operation of deployment and penetration motors.)
- d. Place DIGITAL VOLTMETER MONITOR to left position and place PWR. SUPPLY switch at 22V. Adjust 22-volt power supply to obtain +17-volt output.
- e. Measure and note deflection of trace No. 4. (This is reference for 17-volt operation of rotation motor.)
- f. Readjust 22-volt power supply for 22-volt output.

Note

If test is to be conducted with +28 volts on the deployment and penetration motors, adjust R 307 to obtain 5-inch deflection at +28 volts; then measure and note deflection for 17 volts.

Front-Panel Calibration Pots: (Adjust before operation, each time LSPMD tests are performed.)

- a. Place RECORDER MONITOR at CAL.
- b. Place CALIBRATION VOLTAGE switch at 5.

- c. Press LSPMD LOAD, PUSH TO CALIBRATE button and adjust LSPMD LOAD pot. to obtain a 5-inch deflection on trace No. 9.
- d. Turn CALIBRATION VOLTAGE switch through all positions -- at each position, press the LSPMD LOAD and measure and note deflection of trace No. 9.
- e. Repeat steps b through d for each of the PUSH TO CALIBRATE buttons and associated pots. , except adjust TEST FIXTURE TORQUE pot. with CALIBRATION VOLTAGE at 4. The recorder trace numbers for each of the channels are:

	<u>Channel</u>	<u>Trace No.</u>
LSPMD:		
	Load	9
	Torque	10
	Pot	11
TEST FIXTURE		
	Load	13
	Torque	14
	Pot	15

Test Fixture Load and Torque Channel Calibration Voltage Pot. R 141:
(Perform once weekly.)

- a. Place RECORDER MONITOR at CAL.
- b. Place CALIBRATION VOLTAGE at 5.
- c. Disconnect digital voltmeter cable from control panel connector and connect digital voltmeter across terminals of R 141. (See Fig. 2-5.)
- d. Adjust R 141 to obtain 0.440-volt indication, while TEST FIXTURE LOAD PUSH TO CALIBRATE button is pressed.

Pot. Power and Strain Gage Power Calibration:

- a. Place POT. POWER and STRAIN GAGE POWER switches at ON.
- b. Adjust R 301 (pot. power) to obtain a 5-inch deflection of tract No. 2.
- c. Adjust R 303 (strain gage power) to obtain a 5-inch deflection of trace No. 3.

2-12. Installing LSPMD in Test Fixture (See Fig. 2-6.)

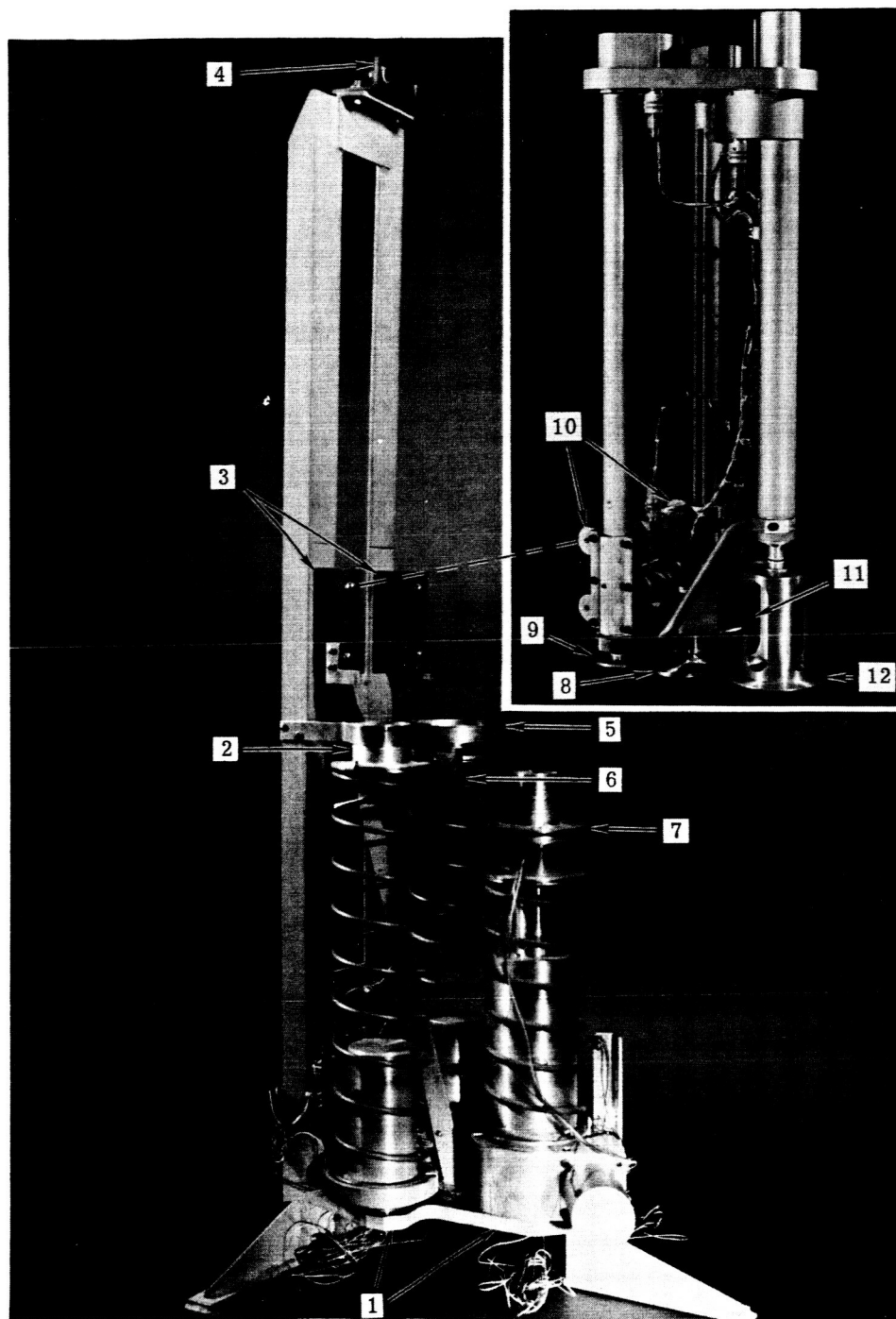
- a. Bolt LSPMD to side mounting bracket.
- b. If necessary, loosen side brackets and align LSPMD shear unit with the engaging plate on the test fixture.
- c. Tighten side brackets.
- d. Bolt LSPMD to the sway-brace
- e. If necessary, loosen the test fixture 2-inch and 4-inch load cells and align with LSPMD pads.

2-13. Connecting Test Console to Test Fixture and LSPMD

CAUTION

Do not connect test console to LSPMD until the following control settings are made. (Switches S30 and S31 by-pass the load limit switches on the LSPMD 2-inch and 4-inch thrust motors. When S30 and S31 are ON, the thrust motors will not automatically stop when driven down.)

- a. Switches S30 and S31 at OFF (down). (See Fig. 2-5.)
- b. All LUNAR SOIL PROPERTIES MEASURING DEVICE switches on control panel, at center (off) positions.
- c. STRAIN GAGE POWER at OFF.
- d. POT POWER at OFF.
- e. TEST FIXTURE POWER at OFF.



- | | | |
|-----------------------------|-----------------------------|----------------------|
| 1 Load Cell Adjusting Nuts | 5 4-inch Pad Engaging Plate | 9 2-inch Pad |
| 2 2-inch Pad Engaging Plate | 6 Deployment Sensor Catch | 10 Mounting Brackets |
| 3 Side Brackets | 7 Shear Unit Engaging Plate | 11 4-inch Pad |
| 4 Sway Brace | 8 Deployment Sensor | 12 Shear |

Figure 2-6. LSPMD Installation

- f. MOTOR at center (off) position.
- g. Connect cable from J2 of test console to J10 of LSPMD.
- h. Connect cable from J3 of test console to J1 of Test fixture.

2-14. PRELIMINARY LSMPD TEST OPERATIONS

Note

See applicable LSPMD test specification for detailed LSPMD test procedures. The following operations are to be performed at the beginning of the LSPMD tests.

2-15. Power Supply Check and Adjustment Under Load

- a. Place DIGITAL VOLTMETER MONITOR at PWR. SUPPLIES (left).
- b. Place TEST FIXTURE POWER, STRAIN GAGE POWER, AND POT POWER switches at ON.
- c. Place PWR. SUPPLIES switch at each voltage position and check for proper indication on digital voltmeter. Readjust power supplies as necessary.

2-16. Monitoring Circuit Adjustments

- a. Set timing line generator switch, on recorder, for one-second intervals.
- b. Check adjustment of front-panel calibration pots. (para. 2-11).

2-17. Preliminary Deployment-Test Operation

- a. Place RECORDER MONITOR at DEPL.
- b. Set recorder for one-inch-per-second chart transport (button 1).

2-18. Preliminary 2-Inch-Test Operation

- a. Place RECORDER MONITOR AT 2".
- b. Set recorder for 1/4 inch-per-second (.25 button).

2-19. Preliminary 4-Inch-Test Operation

- a. Place RECORDER MONITOR at 4".
- b. Set recorder for 1/4-inch-per second (.25 button).

2-20. Preliminary Shear-Unit-Test Operation

- a. Place RECORDER MONITOR at S. U.
- b. Set recorder for 1/4-inch-per-second (.25 button).
- c. Place S. U. THRUST CURRENT switch at 6V. During operation of S. U. unit, watch trace No. 5. (thrust motor voltage) and turn S. U. THRUST CURRENT to 10V and 17V positions as trace jumps to 10 volts and 17 volts.

2-21. USING TEST CONSOLE TO TROUBLESHOOT LSPMD

2-22. General Method

If abnormal indications occur in any of the LSPMD tests, the console may be used to isolate trouble by means of controls, indicators, and the continuity check feature. As a general method of troubleshooting, determine if supply voltage is present at the LSPMD component suspected of malfunction. If supply voltage is present, check continuity across the component, using the appropriate front-panel jacks.

2-23. Examples

If the 2-inch LSPMD pad fails to move up or down when controls are operated, set RECORDER MONITOR at 2" and examine recorder chart to determine if motor voltage is present. If voltage is present, set PWR. SUPPLIES switch at CONTINUITY CHECK and connect test leads from the CONTINUITY CHECK jacks to the 2" pad M jacks and observe digital voltmeter. If the recorder indicates abnormal or absent outputs from the load cells or potentiometers, verify the abnormal output on the digital voltmeter by using the

OUTPUTS switch, then proceed with continuity check, see Table 2-1, to determine specific use of controls for monitoring LSPMD voltages.

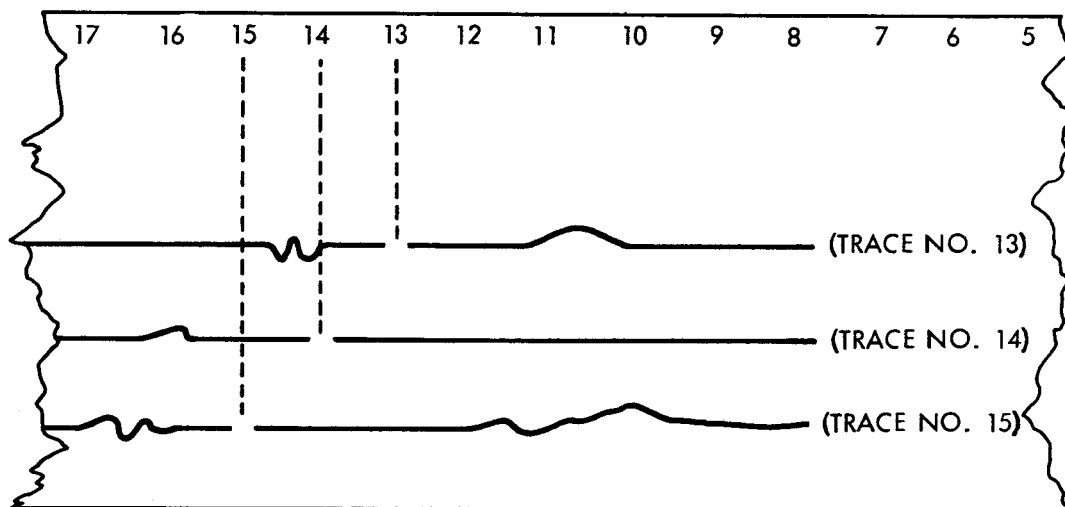


Figure 2-7. Recorder Charts

SECTION III FUNCTIONAL EXPLANATION

Note

For functional explanation of digital voltmeter, oscillograph recorder, and power supplies, see manufacturer's brochures.

3-1. FUNCTIONAL EXPLANATION OF LSPMD

The following description is included to assist in relating functions of the test console and fixture to LSPMD Operations. (See Fig. 3-1.)

- 3-2. General. The Lunar Soil Properties Measuring Device provides information about the traction and load-bearing properties of lunar soil by measuring the force developed against pads deployed into the ground. The LSPMD operates from a fixed position and has three probing units, terminated as follows: a 2-inch diameter pad, a 4-inch diameter pad, and a rotating shear. The sequence of LSPMD operations begins with the simultaneous downward deployment of all three units until the soil is reached; the units then operate individually. The 2-inch pad and 4-inch pad are driven down and each unit measures thrust distance into the soil and force against the thrust of the descending pad. The shear unit is driven down while being rotated and measures thrust against the downward motion and torque against the rotation of the shear. The units continue to be driven down until a force of approximately 45 pounds is encountered or until the extension limit of a unit is reached. If a 45-pound force is encountered against a unit, a pressure operated switch stops the driving motor.

- 3-3. Deployment. The deployment is accomplished by a motor which drives all three units down until the deployment sensor reaches the soil. The

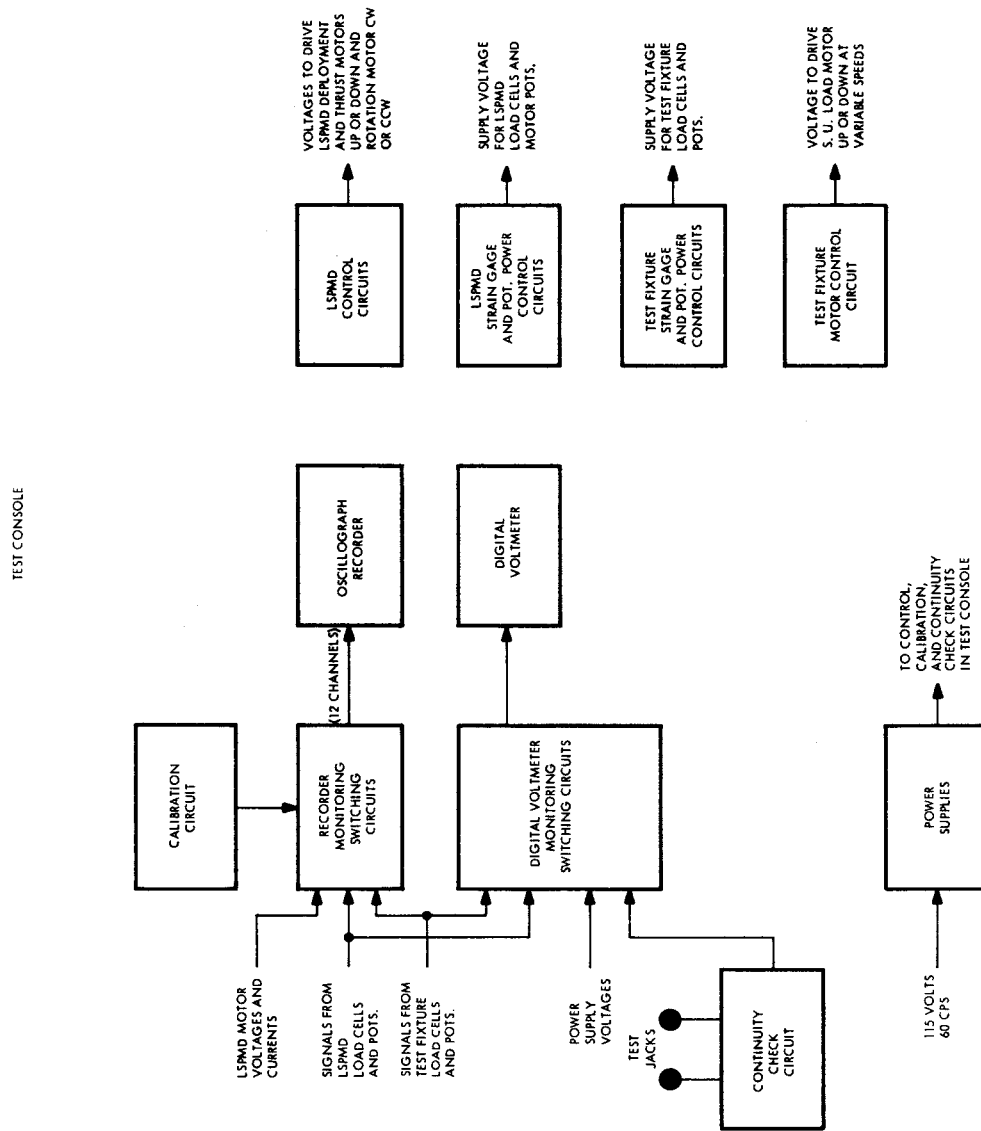


Figure 3-1. LSPMD Test Console and Fixture, Block Diagram (Sheet 1 of 2)

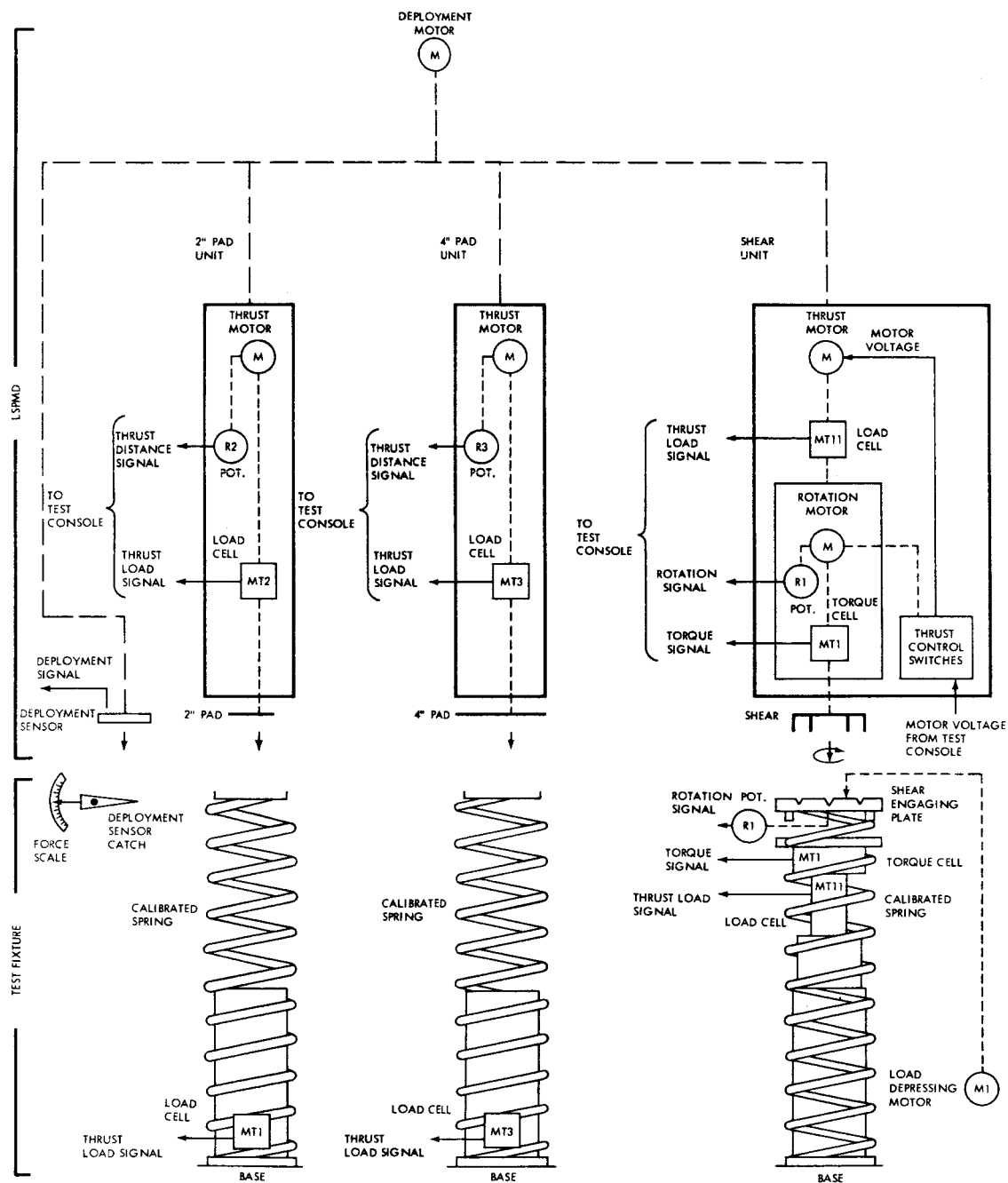


Figure 3-1. LSPMD Test Console and Fixture, Block Diagram (Sheet 2 of 2)

deployment sensor is located slightly below the retracted level of the three pads and operates a switch which stops the deployment motor. Thereafter, the pads are driven by individual motors within each unit.

- 3-4. Operation of 2-Inch and 4-Inch Units. The 2-inch and 4-inch units are identical in operation. The thrust motor drives the pad down until the limit force is reached or until the maximum extension is reached. A strain gage (load cell) in the unit responds to the load encountered by the pad and produces the thrust load signal. (The load cell is not used to sense the limit for the motor; this is done by a spring and switch.) A ten-turn potentiometer is driven by the motor and produces a signal that is a function of the distance travelled by the pad.
- 3-5. Shear Unit. The shear unit has a thrust motor and a thrust load cell which function the same as those in the 2-inch and 4-inch units. (There is no thrust motor potentiometer in the shear unit.) A rotation motor drives the shear unit through one revolution as it descends. A potentiometer driven by the rotation motor provides a signal which represents the amount of shear unit rotation. A strain gage (torque cell) measures the torque developed by the rotating shear as it engages the soil. A cam-operated switching system changes the voltage applied to the thrust motor as the shear rotates. The thrust motor is started with 17.0 volts, to break a seal which holds the unit in place before operation. When the shear has rotated approximately 5 degrees, the thrust motor is switched to 6.0 volts. After another 115 degrees of rotation (approx.) the motor is switched to 10.0 volts. After the next 115 degrees (approx.) the motor is switched to 17.0 volts again for the remainder of the revolution. The use of three thrust motor voltages enables measurement of torque under three different load conditions.

3-6. TEST CONSOLE AND FIXTURE

3-7. General. (See Fig. 3-1.) The test console supplies operating voltages for the LSPMD and monitors outputs from the strain gages and potentiometers. The test fixture provides a mechanical load for the LSPMD by a system of springs, which are each compressed by an LSPMD pad, as it descends. The force exerted by the spring is a function of the distance it is compressed and is sensed by the load cells in the LSPMD and test fixture. The load cell signals are simultaneously recorded by the oscillograph in the console.

3-8. The load assembly for the shear unit has a notched plate which engages the teeth of the shear and is rotated by it. The rotating plate slips against a non-rotating plate mounted to the test fixture torque cell. As the shear descends and the rotating plate is forced against the fixed plate, the cell senses the resulting torque. The test fixture motor drives the shear unit load down as the shear descends; this simulates the effect of soil receding from the rotating shear. The potentiometer provides a signal representing the shear rotation. The load cell performs the same function as those of the 2-inch and 4-inch units.

3-9. CONTROL PANEL CIRCUIT OPERATION

(See schematic diagram, General Motors DRL SK 01876.) On the schematic, external connections are: J1 to power supplies, J2 to LSPMD, J3 to test fixture, J4 thru J15 to oscillograph recorder, and J16 to external magnetic recorder. Dashed lines enclose LSPMD circuits. Numbers enclosed in triangles are monitoring points and are connected to selector switch terminals noted in adjacent numbers. To relate schematic designations to control panel designations, see Table 2-1.

3-10. Power Control. All power supply voltages, except +24 volts dc, are connected to control circuits in the panel through relays K1 and K2, which

are energized when the PWR supply switch is at any position except CONTINUITY CHECK and +24-volts is applied from the dc power switch in the control panel.

- 3-11. Deployment Motor Control. When Deployment switch S1 is placed at DOWN, +22 volts is applied through K2B, S1, S10 (in either CONTINUOUS OR MOMENTARY), and R107 to J2F, which is connected to one side of the deployment motor through the deployment switch in the LSPMD. The other side of the motor is connected to the +22 volt return from J2 through S1 and K2A. When the DEPLOYMENT switch S1 is placed at UP, polarity of the motor voltage is reversed, as follows: The +22 volts is applied through K2B and S1 to J2, connected to one side of the motor. The other side of the motor is connected from J2 (by-passing the deployment switch in LSPMD) through S10 (in MOMENTARY only), S1, and K2A to +22 volt return.
- 3-12. 2-Inch and 4-Inch Motor Controls. The 2-inch and 4-inch control circuits operate the same as the deployment circuit. Switches S2 and S11 control the 2-inch motor and switches S3 and S12 control the 4-inch motor. The internal switches shown on the motors are for load limiting. Control panel switches S30 and S31 by-pass the limit switches.
- 3-13. Shear Unit Control. The SHEAR UNIT switch S4 is used in conjunction with S13 to simultaneously rotate and drive the shear unit down. When S4 is at DOWN, relay K3 is energized through the LSPMD shear overload switch. The control circuit simultaneously supplies +17 volts, +6 volts, and +10 volts to the shear unit switches, which select one of the voltages for the thrust motor, depending upon the angular position of the shear. The +17 volt power is applied through K2-F, K3-A, S4, S13, and R104 to J2m. The other side of the thrust motor is connected from J2-J, through S4 and K2-E to the +17 volt return. The +6 volt power is applied through K1-D,

K3-D, R102, to J2-b and from J2-J, K3-C, K1-C to +6 volt return. The +10 volt circuit is through K1-B, K3-B, R103, to J2-K and from J2-J through K3-C and K1-A to +10 volt return. The rotation motor is energized from +17 volts through K2-F, K3-A, S4 (upper), S13, S4 (lower), R110, to J2-E and the rotation motor, through the internal CW limit switch. The rotation motor return is common to the thrust motor return.

3-14. **SHEAR THRUST CONTROL**

The SHEAR THRUST switch S5, in conjunction with S14, is used to drive the shear unit up or down, without rotation. With S5 at DOWN, relay K3 is energized and the three voltages are applied to the thrust motor switches as follows:

+17 volts through K2-F, K3-A, S5, and S14 to J2m; J2J through S5, and K2-E to +17 volt return.

+6 volts through K1-D, K3-D, R102, to J2-b; J2-J through K3-C and K1-C to +6 volt return.

+10 volts through K1-B, K3-B, R103, to J2-K; J2-J through K3-C and K1-A to +10 volt return.

With S5 at UP, relay K4 is energized and +17 volt power is applied to thrust motor as follows: (+6 volt and +10 volt power are not used for UP operation)

+17 volts through K2-F and S5 to J2-J; J2-m through S14 and S5 to +17 volt return.

3-15. Shear Rotation Control. The SHEAR ROTATION switch, S6, is used in conjunction with S15 to rotate the shear clockwise or counterclockwise without thrust. With S6 at CW, +17 volts is applied to the rotation motor as follows:

+17 volts through K2-F, S6, and S15 to J2-E and the rotation motor through the internal CW limit switch; J2-J through S6, K4-A (un-energized), and K2-E to +17 volt return.

With S6 at CCW, +17 volts is applied in the reverse polarity as follows:
+17 volts through K2-F and K3-A (un-energized) to J2-J; J2-p (from the CCW limit switch) through S15, S6, and K2-E to +17 volt return.

- 3-16. Test Fixture Motor Control. Motor M1 on the test fixture, drives the shear unit load down and is controlled by TEST FIXTURE MOTOR switch, S9, and SPEED CONTROL, S8, which selects a reduced voltage from the +24 volt supply.
- 3-17. DIGITAL VOLTMETER MONITORING CIRCUITS
DIGITAL VOLTMETER MONITOR S28 connects the digital voltmeter inputs, E1 and E2, to either the OUTPUTS switch, S29, or PWR. SUPPLIES switch S27. Switch S27 selects each of the outputs from power supplies in the test console and S29 selects output signals from the strain gages and potentiometers of the test fixture and LSPMD. (See Table 2-1 for function of each position of PWR. SUPPLIES and OUTPUTS switches.)
- 3-18. Oscillograph Recorder Monitoring Circuits. RECORDER MONITOR switch S26 connects monitoring points (designated on the schematic by numbers in triangles) to jacks J4 through J15, which are connected to the recorder. Voltage dividers provide the millivolt inputs required by the recorder, as follows: Potentiometer R302, with R112 and R113, develop S. U. thrust-motor voltage. Potentiometer R307, with associated resistors, develops the motor-voltage signal for the 2-inch, 4-inch, deployment, and rotation circuits. Potentiometers R301 and R303, with associated resistors, develop the pot-power and strain gage input voltage signals. Series resistors, such as R104, are used to develop millivolt signals as a function of motor current. When S26 is at S. U., S. U. THRUST CURRENT switch S18 is employed to select the +6, +10, or +17 volt S. U. thrust

motor circuit. (See Table 2-1 for functions of each position of the RECORDER MONITOR switch.)

- 3-19. Calibration Circuits. When the RECORDER MONITOR switch S26 is at CAL, CALIBRATION VOLTAGE switch S19 selects increments of +5.0 volts, for application to the recorder input circuits. PUSH TO CALIBRATE switches S20 thru S25 apply the selected calibration voltage to any of the recorder input jacks J10 through J15. The calibration potentiometers are adjusted to provide the correct recorder deflection for full scale calibration voltage. (See Table 2-1 for further of each PUSH TO CALIBRATE switch.)
- 3-20. Continuity Check Circuit. With PWR. SUPPLIES switch S27 at CONTINUITY CHECK, relays K1 and K2 are de-energized, removing power supply voltage from all the LSPMD motor-control, potentiometer, and strain gage circuits in the control panel. The DIGITAL VOLTMETER MONITOR switch is placed at PWR. SUPPLIES position and an ohmmeter circuit is formed as follows: From K1-D (un-energized) +6 volts is connected through R101, to the E1 input of the digital voltmeter, through S28 and S29. The E2 input is connected through S28, S29, and K1-C (un-energized) to the +6 volt return. With CONTINUITY CHECK jacks TP-26 and TP-27 open, the voltmeter indicates +6 volts. Any resistance connected across the jacks will be in series with R101 and the 6-volt supply. The digital voltmeter inputs, E1 and E2, are across the jacks; the voltmeter will therefore indicate whatever voltage less than +6.0 is developed across the resistance being measured.

SECTION IV MAINTENANCE

4-1. TROUBLESHOOTING

Trouble analysis of the test console and fixture can be based on operating indications and the information in Section III, Functional Explanation.

The digital voltmeter can be used to measure normal, zero-load outputs of the test fixture strain gages for notation and comparison with outputs when malfunction of the test fixture is suspected. Refer to interconnecting diagram SK 01072 to relate terminals of connector P10 (the connector that plugs into the LSPMD) to the control panel connector J2, shown on schematic SK 01876. Outputs of the console can be checked at P10 (disconnected from LSPMD) when the control panel is operated and a jumper is connected between P10-X and P10-k to simulate the shear-unit overload switch.

4-2. MAINTENANCE OF MAJOR UNITS

When trouble (other than blown fuses) has been isolated to the digital voltmeter, oscillograph recorder, or power supplies, refer to applicable manufacturer's service publication (listed in Section I).

4-3. LOCATION OF FUSES

<u>Location</u>	<u>Rating</u>
Digital voltmeter (rear panel)	0.5 amp. slo-blo
Oscillograph Recorder (rear panel)	F101 5-amp F102 1.5-amp
17-volt power supply	3-amp
22-volt power supply	3-amp
24-volt power supply	10-amp

(4.85, 6.0, 5.0, 10.0 and 20.0 volt supplies have no fuses)